



# Cambridge International AS & A Level

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**BIOLOGY****9700/43**

Paper 4 A Level Structured Questions

**May/June 2023**

MARK SCHEME

Maximum Mark: 100

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**Published**

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the May/June 2023 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

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This document consists of **24** printed pages.

**PUBLISHED****Generic Marking Principles**

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

**GENERIC MARKING PRINCIPLE 1:**

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

**GENERIC MARKING PRINCIPLE 2:**

Marks awarded are always **whole marks** (not half marks, or other fractions).

**GENERIC MARKING PRINCIPLE 3:**

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

**GENERIC MARKING PRINCIPLE 4:**

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

**GENERIC MARKING PRINCIPLE 5:**

Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).

**GENERIC MARKING PRINCIPLE 6:**

Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

### Science-Specific Marking Principles

- |   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|---|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 2 | The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 3 | Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 4 | The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 5 | <p><u>'List rule' guidance</u></p> <p>For questions that require <b><i>n</i></b> responses (e.g. State <b>two</b> reasons ...):</p> <ul style="list-style-type: none"> <li>• The response should be read as continuous prose, even when numbered answer spaces are provided.</li> <li>• Any response marked <i>ignore</i> in the mark scheme should not count towards <b><i>n</i></b>.</li> <li>• Incorrect responses should not be awarded credit but will still count towards <b><i>n</i></b>.</li> <li>• Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should <b>not</b> be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response.</li> <li>• Non-contradictory responses after the first <b><i>n</i></b> responses may be ignored even if they include incorrect science.</li> </ul> |

**6** Calculation specific guidance

Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'.

For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values.

For answers given in standard form (e.g.  $a \times 10^n$ ) in which the convention of restricting the value of the coefficient ( $a$ ) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme.

Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.

**7** Guidance for chemical equations

Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme.

State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

## Mark scheme abbreviations:

|                  |                                                                                  |
|------------------|----------------------------------------------------------------------------------|
| ;                | separates marking points                                                         |
| /                | alternative answers for the same marking point                                   |
| <b>R</b>         | reject                                                                           |
| <b>A</b>         | accept                                                                           |
| <b>I</b>         | ignore                                                                           |
| AVP              | any valid point                                                                  |
| AW               | alternative wording (where responses vary more than usual)                       |
| ecf              | error carried forward                                                            |
| <u>underline</u> | actual word underlined must be used by candidate (grammatical variants accepted) |
| max              | indicates the maximum number of marks that can be given                          |
| ora              | or reverse argument                                                              |

| Question | Answer                                                                                                                                                                                                                                                                                                                                                                                  | Marks    |
|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| 1(a)     | <p><b>P</b> – citrate <b>A</b> citric acid</p> <p><b>Q</b> – NAD / NAD<sup>+</sup></p> <p><b>R</b> – reduced NAD / NADH <b>A</b> NADH<sub>2</sub></p> <p><b>S</b> – carbon dioxide / CO<sub>2</sub></p> <p><b>T</b> – FAD</p> <p><b>U</b> – reduced FAD / FADH<sub>2</sub> ;;;</p> <p><i>6 correct = 3 marks</i><br/> <i>5/4 correct = 2 marks</i><br/> <i>3/2 correct = 1 mark</i></p> | <b>3</b> |
| 1(b)     | <p>any <b>two</b> from:</p> <p>1 transfer of phosphate group to ADP / ADP phosphorylated / ADP + P<sub>i</sub> → ATP ;</p> <p>2 substrate-linked phosphorylation ;<br/> <b>A</b> substrate-level phosphorylation<br/> <b>R</b> if oxidative phosphorylation</p> <p>3 enzyme (catalysed reaction) ;</p>                                                                                  | <b>2</b> |

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| Question | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Marks    |
|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| 1(c)     | <p><i>any <b>four</b> from:</i></p> <ol style="list-style-type: none"> <li>1 small / water-soluble, so can move around <u>cell</u> ;</li> <li>2 loss of phosphate / hydrolysis, leads to energy release ;</li> <li>3 (release energy) immediately / in small packets<br/><b>or</b><br/><i>ref.</i> 30.5 kJ (mol<sup>-1</sup>) ;</li> <li>4 can be, recycled / regenerated<br/><b>or</b><br/>ATP <math>\rightleftharpoons</math> ADP + Pi ;</li> <li>5 link between energy-yielding and energy-requiring reactions / AW ;</li> <li>6 high turnover / described ;</li> <li>7 <i>ref to</i> ATPase ;</li> </ol> | <b>4</b> |

| Question | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Marks |
|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 2        | <p><i>any <b>seven</b> from:</i></p> <ol style="list-style-type: none"> <li>1 (random) mutation ;</li> <li>2 directional selection ;</li> <li>3 antibiotic acts as selection pressure / AW ;</li> <li>4 bacteria with, mutation / gene / allele, (that codes for antibiotic resistance), have selective advantage ;</li> <li>5 (so) survive / reproduce ;</li> <li>6 <i>ref.</i> binary fission / asexual reproduction / vertical transmission ;</li> <li>7 <i>ref.</i> transduction / transformation / conjugation / horizontal transmission ;<br/>I sexual reproduction</li> <li>8 (resistance) allele frequency increases / gives rise to a population of resistant bacteria ;</li> <li>9 fast (evolution) due to short generation time ;</li> <li>10 increased chance of resistance if people do not finish full course of antibiotics / overuse of antibiotics ;</li> <li>11 AVP ; e.g. some antibiotics may act as mutagens<br/>e.g. enzymes that break down the antibiotic</li> </ol> | 7     |

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| Question    | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Marks                                               |           |                                   |             |           |                                                     |             |           |                            |          |
|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|-----------|-----------------------------------|-------------|-----------|-----------------------------------------------------|-------------|-----------|----------------------------|----------|
| 3(a)(i)     | <p><i>the operon has:</i></p> <p>promoter ;</p> <p>operator ;</p> <p>three structural genes / named three structural genes ;</p> <table border="1"> <tr> <td><i>lacZ</i></td><td><b>or</b></td><td><math>\beta</math> galactosidase <u>gene</u></td></tr> <tr> <td><i>lacA</i></td><td><b>or</b></td><td>lactose / <math>\beta</math> galactoside, permease <u>gene</u></td></tr> <tr> <td><i>lacY</i></td><td><b>or</b></td><td>transacetylase <u>gene</u></td></tr> </table> <p><i>I regulatory genes / order of named parts</i></p> | <i>lacZ</i>                                         | <b>or</b> | $\beta$ galactosidase <u>gene</u> | <i>lacA</i> | <b>or</b> | lactose / $\beta$ galactoside, permease <u>gene</u> | <i>lacY</i> | <b>or</b> | transacetylase <u>gene</u> | <b>3</b> |
| <i>lacZ</i> | <b>or</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | $\beta$ galactosidase <u>gene</u>                   |           |                                   |             |           |                                                     |             |           |                            |          |
| <i>lacA</i> | <b>or</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | lactose / $\beta$ galactoside, permease <u>gene</u> |           |                                   |             |           |                                                     |             |           |                            |          |
| <i>lacY</i> | <b>or</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | transacetylase <u>gene</u>                          |           |                                   |             |           |                                                     |             |           |                            |          |
| 3(a)(ii)    | <p><i>any <b>four</b> from:</i></p> <p><i>lacI gene</i></p> <p>1 is always expressed ;</p> <p>2 controls (structural) gene expression ;</p> <p>3 codes for the repressor (protein) ;</p> <p>4 repressor, binds to the operator / blocks the promoter ;</p> <p>5 prevents, (structural) gene expression / RNA polymerase binding to promoter ;</p> <p>6 lactose / allolactose, binds to repressor ;</p> <p>7 (so) repressor cannot bind to operator / promoter unblocked / gene expression can occur ;</p>                              | <b>4</b>                                            |           |                                   |             |           |                                                     |             |           |                            |          |

| Question | Answer                                                                                                                                                                                                 | Marks |
|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 3(b)     | 1 enzymes / proteins, made continuously / all the time ;<br>2 (because) enzymes / proteins, needed / necessary (for cell) ;<br>3 end product inhibition / made until product concentrations too high ; | 3     |

| Question | Answer                                                                                                                                                                                                                                                    | Marks |
|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 4(a)     | <i>any <b>three</b> from:</i><br>1 donor not needed ;<br>2 immediate effect ;<br>3 <i>idea that</i> easy to administer treatment ;<br>4 no immune response / no rejection ;<br>5 less invasive ;<br>6 AVP ; e.g. lower risk to health / cheaper / quicker | 3     |

| Question | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Marks    |
|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| 4(b)     | <p><i>any <b>four</b> from:</i></p> <ol style="list-style-type: none"> <li>1 given a drug to increase number of stem cells (in bone marrow) ;</li> <li>2 <i>ref. to</i> virus / vector, containing, normal / healthy, allele ;</li> <li>3 remove, bone marrow / stem cells ;</li> <li>4 mix stem cells with, viral / vector (to allow transfer of normal allele) ;</li> <li>5 radiotherapy / drug, to make space in bone marrow / to kill stem cells (in bone marrow) ;</li> <li>6 (transduced stem) cells, infused / injected, into blood ;</li> <li>7 (lymphocytes) produce functioning ADA ;</li> <li>8 AVP ; e.g. (gamma) retrovirus / adeno-associated virus<br/>e.g. tissue from bone marrow, purified / sorted, to obtain stem cells<br/>e.g. cells are grown in culture to check the ADA gene is active</li> </ol> | <b>4</b> |

| Question | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Marks    |
|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| 4(c)     | <p>any <b>three</b> from:</p> <ol style="list-style-type: none"> <li>1 expensive ;</li> <li>2 cure / long term treatment / no longer chronically ill / better quality of life ;</li> <li>3 no need for regular, injections / treatments<br/><b>or</b><br/>only a single treatment ;</li> <li>4 cultural / religious, objections ;</li> <li>5 no donor needed ;</li> <li>6 <i>ref.</i> more money available to health system in the long term ;</li> <li>7 may cause cancer ;</li> <li>8 stressful ;</li> </ol> | <b>3</b> |

| Question               | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Marks     |          |                      |                           |                      |                       |                      |     |        |       |        |       |                        |    |       |      |        |       |     |    |       |      |        |       |       |    |       |         |          |         |  |  |  |  |  |                           |   |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|----------|----------------------|---------------------------|----------------------|-----------------------|----------------------|-----|--------|-------|--------|-------|------------------------|----|-------|------|--------|-------|-----|----|-------|------|--------|-------|-------|----|-------|---------|----------|---------|--|--|--|--|--|---------------------------|---|
| 5(a)                   | <table><tr><th>phenotype</th><th>observed</th><th>expected</th><th>O – E</th><th>(O – E)<sup>2</sup></th><th><math>\frac{(O - E)^2}{E}</math></th></tr><tr><td>red with black spots</td><td>279</td><td>281.25</td><td>–2.25</td><td>5.0625</td><td>0.018</td></tr><tr><td>white with black spots</td><td>95</td><td>93.75</td><td>1.25</td><td>1.5625</td><td>0.017</td></tr><tr><td>red</td><td>96</td><td>93.75</td><td>2.25</td><td>5.0625</td><td>0.054</td></tr><tr><td>white</td><td>30</td><td>31.25</td><td>–1.25 ;</td><td>1.5625 ;</td><td>0.05(0)</td></tr><tr><td colspan="5"></td><td><b>0.139 /<br/>0.14 ;</b></td></tr></table> <p>one mark for each column</p> | phenotype | observed | expected             | O – E                     | (O – E) <sup>2</sup> | $\frac{(O - E)^2}{E}$ | red with black spots | 279 | 281.25 | –2.25 | 5.0625 | 0.018 | white with black spots | 95 | 93.75 | 1.25 | 1.5625 | 0.017 | red | 96 | 93.75 | 2.25 | 5.0625 | 0.054 | white | 30 | 31.25 | –1.25 ; | 1.5625 ; | 0.05(0) |  |  |  |  |  | <b>0.139 /<br/>0.14 ;</b> | 3 |
| phenotype              | observed                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | expected  | O – E    | (O – E) <sup>2</sup> | $\frac{(O - E)^2}{E}$     |                      |                       |                      |     |        |       |        |       |                        |    |       |      |        |       |     |    |       |      |        |       |       |    |       |         |          |         |  |  |  |  |  |                           |   |
| red with black spots   | 279                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 281.25    | –2.25    | 5.0625               | 0.018                     |                      |                       |                      |     |        |       |        |       |                        |    |       |      |        |       |     |    |       |      |        |       |       |    |       |         |          |         |  |  |  |  |  |                           |   |
| white with black spots | 95                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 93.75     | 1.25     | 1.5625               | 0.017                     |                      |                       |                      |     |        |       |        |       |                        |    |       |      |        |       |     |    |       |      |        |       |       |    |       |         |          |         |  |  |  |  |  |                           |   |
| red                    | 96                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 93.75     | 2.25     | 5.0625               | 0.054                     |                      |                       |                      |     |        |       |        |       |                        |    |       |      |        |       |     |    |       |      |        |       |       |    |       |         |          |         |  |  |  |  |  |                           |   |
| white                  | 30                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 31.25     | –1.25 ;  | 1.5625 ;             | 0.05(0)                   |                      |                       |                      |     |        |       |        |       |                        |    |       |      |        |       |     |    |       |      |        |       |       |    |       |         |          |         |  |  |  |  |  |                           |   |
|                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |           |          |                      | <b>0.139 /<br/>0.14 ;</b> |                      |                       |                      |     |        |       |        |       |                        |    |       |      |        |       |     |    |       |      |        |       |       |    |       |         |          |         |  |  |  |  |  |                           |   |
| 5(b)                   | <p>any <b>two</b> from:</p> <p>accept null hypothesis (no mark)</p> <p>1 <math>\chi^2</math> value / 0.139 / 0.14, is lower than, the critical value / 7.815 ;</p> <p>2 the observed numbers are not significantly different to the expected numbers (at <math>p = 0.05</math>) ;</p> <p>3 any differences are due to chance ;</p> <p>allow ecf from <b>5(a)</b></p>                                                                                                                                                                                                                                                                                                            | 2         |          |                      |                           |                      |                       |                      |     |        |       |        |       |                        |    |       |      |        |       |     |    |       |      |        |       |       |    |       |         |          |         |  |  |  |  |  |                           |   |

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| Question         | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                  |                                  |                                  |  | Marks |                |  |  |  |              |                  |                  |                  |                  |                  |                                  |                                  |                                  |                                  |        |        |        |        |                   |                     |                   |                     |                  |                                  |                                  |                                  |                                  |      |      |      |      |                   |                   |                   |                   |                  |                                  |                                  |                                  |                                  |        |        |        |        |                   |                     |                |                  |                  |                                  |                                  |                                  |                                  |      |      |      |      |                   |                   |                |                |   |
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| 5(c)             | <table><tr><td></td><td colspan="4">female gametes</td></tr><tr><td>male gametes</td><td>X<sup>R</sup>B</td><td>X<sup>r</sup>B</td><td>X<sup>R</sup>b</td><td>X<sup>r</sup>b</td></tr><tr><td rowspan="3">X<sup>r</sup>B</td><td>X<sup>R</sup>X<sup>r</sup>BB</td><td>X<sup>r</sup>X<sup>r</sup>BB</td><td>X<sup>R</sup>X<sup>r</sup>Bb</td><td>X<sup>r</sup>X<sup>r</sup>Bb</td></tr><tr><td>female</td><td>female</td><td>female</td><td>female</td></tr><tr><td>red + black spots</td><td>white + black spots</td><td>red + black spots</td><td>white + black spots</td></tr><tr><td rowspan="3">Y<sup>R</sup>B</td><td>X<sup>R</sup>Y<sup>R</sup>BB</td><td>X<sup>r</sup>Y<sup>R</sup>BB</td><td>X<sup>R</sup>Y<sup>R</sup>Bb</td><td>X<sup>r</sup>Y<sup>R</sup>Bb</td></tr><tr><td>male</td><td>male</td><td>male</td><td>male</td></tr><tr><td>red + black spots</td><td>red + black spots</td><td>red + black spots</td><td>red + black spots</td></tr><tr><td rowspan="3">X<sup>r</sup>b</td><td>X<sup>R</sup>X<sup>r</sup>Bb</td><td>X<sup>r</sup>X<sup>r</sup>Bb</td><td>X<sup>R</sup>X<sup>r</sup>bb</td><td>X<sup>r</sup>X<sup>r</sup>bb</td></tr><tr><td>female</td><td>female</td><td>female</td><td>female</td></tr><tr><td>red + black spots</td><td>white + black spots</td><td>red + no spots</td><td>white + no spots</td></tr><tr><td rowspan="3">Y<sup>R</sup>b</td><td>X<sup>R</sup>Y<sup>R</sup>Bb</td><td>X<sup>r</sup>Y<sup>R</sup>Bb</td><td>X<sup>R</sup>Y<sup>R</sup>bb</td><td>X<sup>r</sup>Y<sup>R</sup>bb</td></tr><tr><td>male</td><td>male</td><td>male</td><td>male</td></tr><tr><td>red + black spots</td><td>red + black spots</td><td>red + no spots</td><td>red + no spots</td></tr></table> |                                  |                                  |                                  |  |       | female gametes |  |  |  | male gametes | X <sup>R</sup> B | X <sup>r</sup> B | X <sup>R</sup> b | X <sup>r</sup> b | X <sup>r</sup> B | X <sup>R</sup> X <sup>r</sup> BB | X <sup>r</sup> X <sup>r</sup> BB | X <sup>R</sup> X <sup>r</sup> Bb | X <sup>r</sup> X <sup>r</sup> Bb | female | female | female | female | red + black spots | white + black spots | red + black spots | white + black spots | Y <sup>R</sup> B | X <sup>R</sup> Y <sup>R</sup> BB | X <sup>r</sup> Y <sup>R</sup> BB | X <sup>R</sup> Y <sup>R</sup> Bb | X <sup>r</sup> Y <sup>R</sup> Bb | male | male | male | male | red + black spots | red + black spots | red + black spots | red + black spots | X <sup>r</sup> b | X <sup>R</sup> X <sup>r</sup> Bb | X <sup>r</sup> X <sup>r</sup> Bb | X <sup>R</sup> X <sup>r</sup> bb | X <sup>r</sup> X <sup>r</sup> bb | female | female | female | female | red + black spots | white + black spots | red + no spots | white + no spots | Y <sup>R</sup> b | X <sup>R</sup> Y <sup>R</sup> Bb | X <sup>r</sup> Y <sup>R</sup> Bb | X <sup>R</sup> Y <sup>R</sup> bb | X <sup>r</sup> Y <sup>R</sup> bb | male | male | male | male | red + black spots | red + black spots | red + no spots | red + no spots | 4 |
|                  | female gametes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                  |                                  |                                  |  |       |                |  |  |  |              |                  |                  |                  |                  |                  |                                  |                                  |                                  |                                  |        |        |        |        |                   |                     |                   |                     |                  |                                  |                                  |                                  |                                  |      |      |      |      |                   |                   |                   |                   |                  |                                  |                                  |                                  |                                  |        |        |        |        |                   |                     |                |                  |                  |                                  |                                  |                                  |                                  |      |      |      |      |                   |                   |                |                |   |
| male gametes     | X <sup>R</sup> B                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | X <sup>r</sup> B                 | X <sup>R</sup> b                 | X <sup>r</sup> b                 |  |       |                |  |  |  |              |                  |                  |                  |                  |                  |                                  |                                  |                                  |                                  |        |        |        |        |                   |                     |                   |                     |                  |                                  |                                  |                                  |                                  |      |      |      |      |                   |                   |                   |                   |                  |                                  |                                  |                                  |                                  |        |        |        |        |                   |                     |                |                  |                  |                                  |                                  |                                  |                                  |      |      |      |      |                   |                   |                |                |   |
| X <sup>r</sup> B | X <sup>R</sup> X <sup>r</sup> BB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | X <sup>r</sup> X <sup>r</sup> BB | X <sup>R</sup> X <sup>r</sup> Bb | X <sup>r</sup> X <sup>r</sup> Bb |  |       |                |  |  |  |              |                  |                  |                  |                  |                  |                                  |                                  |                                  |                                  |        |        |        |        |                   |                     |                   |                     |                  |                                  |                                  |                                  |                                  |      |      |      |      |                   |                   |                   |                   |                  |                                  |                                  |                                  |                                  |        |        |        |        |                   |                     |                |                  |                  |                                  |                                  |                                  |                                  |      |      |      |      |                   |                   |                |                |   |
|                  | female                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | female                           | female                           | female                           |  |       |                |  |  |  |              |                  |                  |                  |                  |                  |                                  |                                  |                                  |                                  |        |        |        |        |                   |                     |                   |                     |                  |                                  |                                  |                                  |                                  |      |      |      |      |                   |                   |                   |                   |                  |                                  |                                  |                                  |                                  |        |        |        |        |                   |                     |                |                  |                  |                                  |                                  |                                  |                                  |      |      |      |      |                   |                   |                |                |   |
|                  | red + black spots                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | white + black spots              | red + black spots                | white + black spots              |  |       |                |  |  |  |              |                  |                  |                  |                  |                  |                                  |                                  |                                  |                                  |        |        |        |        |                   |                     |                   |                     |                  |                                  |                                  |                                  |                                  |      |      |      |      |                   |                   |                   |                   |                  |                                  |                                  |                                  |                                  |        |        |        |        |                   |                     |                |                  |                  |                                  |                                  |                                  |                                  |      |      |      |      |                   |                   |                |                |   |
| Y <sup>R</sup> B | X <sup>R</sup> Y <sup>R</sup> BB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | X <sup>r</sup> Y <sup>R</sup> BB | X <sup>R</sup> Y <sup>R</sup> Bb | X <sup>r</sup> Y <sup>R</sup> Bb |  |       |                |  |  |  |              |                  |                  |                  |                  |                  |                                  |                                  |                                  |                                  |        |        |        |        |                   |                     |                   |                     |                  |                                  |                                  |                                  |                                  |      |      |      |      |                   |                   |                   |                   |                  |                                  |                                  |                                  |                                  |        |        |        |        |                   |                     |                |                  |                  |                                  |                                  |                                  |                                  |      |      |      |      |                   |                   |                |                |   |
|                  | male                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | male                             | male                             | male                             |  |       |                |  |  |  |              |                  |                  |                  |                  |                  |                                  |                                  |                                  |                                  |        |        |        |        |                   |                     |                   |                     |                  |                                  |                                  |                                  |                                  |      |      |      |      |                   |                   |                   |                   |                  |                                  |                                  |                                  |                                  |        |        |        |        |                   |                     |                |                  |                  |                                  |                                  |                                  |                                  |      |      |      |      |                   |                   |                |                |   |
|                  | red + black spots                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | red + black spots                | red + black spots                | red + black spots                |  |       |                |  |  |  |              |                  |                  |                  |                  |                  |                                  |                                  |                                  |                                  |        |        |        |        |                   |                     |                   |                     |                  |                                  |                                  |                                  |                                  |      |      |      |      |                   |                   |                   |                   |                  |                                  |                                  |                                  |                                  |        |        |        |        |                   |                     |                |                  |                  |                                  |                                  |                                  |                                  |      |      |      |      |                   |                   |                |                |   |
| X <sup>r</sup> b | X <sup>R</sup> X <sup>r</sup> Bb                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | X <sup>r</sup> X <sup>r</sup> Bb | X <sup>R</sup> X <sup>r</sup> bb | X <sup>r</sup> X <sup>r</sup> bb |  |       |                |  |  |  |              |                  |                  |                  |                  |                  |                                  |                                  |                                  |                                  |        |        |        |        |                   |                     |                   |                     |                  |                                  |                                  |                                  |                                  |      |      |      |      |                   |                   |                   |                   |                  |                                  |                                  |                                  |                                  |        |        |        |        |                   |                     |                |                  |                  |                                  |                                  |                                  |                                  |      |      |      |      |                   |                   |                |                |   |
|                  | female                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | female                           | female                           | female                           |  |       |                |  |  |  |              |                  |                  |                  |                  |                  |                                  |                                  |                                  |                                  |        |        |        |        |                   |                     |                   |                     |                  |                                  |                                  |                                  |                                  |      |      |      |      |                   |                   |                   |                   |                  |                                  |                                  |                                  |                                  |        |        |        |        |                   |                     |                |                  |                  |                                  |                                  |                                  |                                  |      |      |      |      |                   |                   |                |                |   |
|                  | red + black spots                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | white + black spots              | red + no spots                   | white + no spots                 |  |       |                |  |  |  |              |                  |                  |                  |                  |                  |                                  |                                  |                                  |                                  |        |        |        |        |                   |                     |                   |                     |                  |                                  |                                  |                                  |                                  |      |      |      |      |                   |                   |                   |                   |                  |                                  |                                  |                                  |                                  |        |        |        |        |                   |                     |                |                  |                  |                                  |                                  |                                  |                                  |      |      |      |      |                   |                   |                |                |   |
| Y <sup>R</sup> b | X <sup>R</sup> Y <sup>R</sup> Bb                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | X <sup>r</sup> Y <sup>R</sup> Bb | X <sup>R</sup> Y <sup>R</sup> bb | X <sup>r</sup> Y <sup>R</sup> bb |  |       |                |  |  |  |              |                  |                  |                  |                  |                  |                                  |                                  |                                  |                                  |        |        |        |        |                   |                     |                   |                     |                  |                                  |                                  |                                  |                                  |      |      |      |      |                   |                   |                   |                   |                  |                                  |                                  |                                  |                                  |        |        |        |        |                   |                     |                |                  |                  |                                  |                                  |                                  |                                  |      |      |      |      |                   |                   |                |                |   |
|                  | male                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | male                             | male                             | male                             |  |       |                |  |  |  |              |                  |                  |                  |                  |                  |                                  |                                  |                                  |                                  |        |        |        |        |                   |                     |                   |                     |                  |                                  |                                  |                                  |                                  |      |      |      |      |                   |                   |                   |                   |                  |                                  |                                  |                                  |                                  |        |        |        |        |                   |                     |                |                  |                  |                                  |                                  |                                  |                                  |      |      |      |      |                   |                   |                |                |   |
|                  | red + black spots                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | red + black spots                | red + no spots                   | red + no spots                   |  |       |                |  |  |  |              |                  |                  |                  |                  |                  |                                  |                                  |                                  |                                  |        |        |        |        |                   |                     |                   |                     |                  |                                  |                                  |                                  |                                  |      |      |      |      |                   |                   |                   |                   |                  |                                  |                                  |                                  |                                  |        |        |        |        |                   |                     |                |                  |                  |                                  |                                  |                                  |                                  |      |      |      |      |                   |                   |                |                |   |
| ****<br>****     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                  |                                  |                                  |  |       |                |  |  |  |              |                  |                  |                  |                  |                  |                                  |                                  |                                  |                                  |        |        |        |        |                   |                     |                   |                     |                  |                                  |                                  |                                  |                                  |      |      |      |      |                   |                   |                   |                   |                  |                                  |                                  |                                  |                                  |        |        |        |        |                   |                     |                |                  |                  |                                  |                                  |                                  |                                  |      |      |      |      |                   |                   |                |                |   |

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| Question | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Marks    |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| 5(d)     | <p><i>mark as pairs</i></p> <p>1 allele <b>R</b> / dominant red allele, is on <b>Y</b> chromosome ;</p> <p>2 (so all) males <b>inherit</b>, dominant red allele / allele <b>R</b><br/><b>or</b><br/>only <b>Y<sup>R</sup></b> is present in the gametes ;</p> <p>3 no, allele <b>r</b> / recessive white allele, on <b>Y</b> chromosome<br/><b>or</b><br/>allele <b>r</b> only exists on the <b>X</b> chromosome ;</p> <p>4 (so) males never inherit, recessive white allele / allele <b>r</b> ;</p> | <b>2</b> |
| 5(e)     | <p>any <b>two</b> from:</p> <p>1 mutation ;</p> <p>2 detail of mutation ;</p> <p>3 crossing over ;</p> <p>4 (of) the <b>R</b> allele / dominant red allele, from a <b>Y</b> chromosome to an <b>X</b> chromosome ;</p>                                                                                                                                                                                                                                                                               | <b>2</b> |

| Question | Answer                                                                                                  | Marks    |
|----------|---------------------------------------------------------------------------------------------------------|----------|
| 6(a)     | <p><b>A</b> – endothelial cell ;</p> <p><b>B</b> – basement membrane ;</p> <p><b>C</b> – podocyte ;</p> | <b>3</b> |

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| Question | Answer                                                                                                                                                                                                                  | Marks    |
|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| 6(b)     | <p><i>any <b>two</b> from:</i></p> <p>1 acts as the filter ;</p> <p>2 prevents molecules more than 68 000 – 70 000 MM from passing through ; <b>ora</b></p> <p>3 stops, large (plasma) proteins / red blood cells ;</p> | <b>2</b> |
| 6(c)     | <p><math>\frac{180 - 1.4}{180} \times 100</math></p> <p><b>or</b></p> <p><math>\frac{178.6}{180} \times 100 ;</math></p> <p>99.2 ;</p>                                                                                  | <b>2</b> |

| Question | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Marks |
|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 6(d)     | <p><i>any <b>seven</b> from:</i></p> <ol style="list-style-type: none"> <li>1 ADH, acts as / is, a cell signalling molecule ;</li> <li>2 ADH binds to receptors ;</li> <li>3 on cell surface membrane (of collecting duct cells) ; I activates G protein</li> <li>4 cAMP / second messenger, produced ;</li> <li>5 enzyme cascade / activation of kinase ;</li> <li>6 vesicles / aquaporins, phosphorylated / activated ;</li> <li>7 vesicles (with aquaporins) move towards cell surface membrane ;</li> <li>8 aquaporins added to (cell surface) membrane ;</li> <li>9 increases, cell / membrane, permeability to water ;</li> <li>10 water moves out (of collecting duct), by osmosis / description ;</li> <li>11 into, (collecting duct) cells / tissue fluid / blood ;<br/>I water is reabsorbed as in Q</li> </ol> | 7     |

| Question | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Marks    |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| 7(a)     | <p>any <b>three</b> from:</p> <ol style="list-style-type: none"> <li>1 opens (voltage-gated) <math>\text{Ca}^{2+}</math> channels in sarcoplasmic reticulum<br/><b>or</b><br/>calcium ions leave sarcoplasmic reticulum ;</li> <li>2 calcium ions bind to troponin ;</li> <li>3 troponin changes shape / tropomyosin moves ;</li> <li>4 exposes binding site on actin ;</li> <li>5 myosin <u>head</u>, binds to (binding) site / forms cross bridge ;</li> </ol> <p><b>plus</b></p> <ol style="list-style-type: none"> <li>6 myosin <u>head</u>, tilts / AW ;</li> <li>7 pulls actin / power stroke (so sarcomere shortens) ;</li> </ol> | <b>4</b> |

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| Question          | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Marks                                                 |                                                                            |                                                       |                   |          |       |                   |          |       |          |
|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|----------------------------------------------------------------------------|-------------------------------------------------------|-------------------|----------|-------|-------------------|----------|-------|----------|
| 7(b)              | <p><i>any <b>two</b> from:</i></p> <ol style="list-style-type: none"> <li>1 young mice have more (muscle fibres) that are smaller (in diameter) ; <b>ora</b></li> <li>2 young mice have smaller range (of diameters of muscle fibres) ; <b>ora</b></li> <li>3 comparative data quote ; e.g.</li> </ol> <table border="1"> <tr> <td></td><td><b>number of muscle fibres at mean diameter / <math>\mu\text{m}</math></b></td><td><b>spread of diameters / <math>\mu\text{m}</math></b></td></tr> <tr> <td><b>young mice</b></td><td>35 at 30</td><td>16–44</td></tr> <tr> <td><b>adult mice</b></td><td>16 at 50</td><td>20–80</td></tr> </table> <p><i>plus</i><br/><i>any <b>two</b> from:</i></p> <p><i>young mice</i></p> <ol style="list-style-type: none"> <li>4 fewer, (muscle) fibres / myofibrils / sarcomeres ; <b>ora</b></li> <li>5 less, muscle protein / actin and myosin ; <b>ora</b></li> <li>6 so, weaker contraction / AW ; <b>ora</b></li> </ol> |                                                       | <b>number of muscle fibres at mean diameter / <math>\mu\text{m}</math></b> | <b>spread of diameters / <math>\mu\text{m}</math></b> | <b>young mice</b> | 35 at 30 | 16–44 | <b>adult mice</b> | 16 at 50 | 20–80 | <b>4</b> |
|                   | <b>number of muscle fibres at mean diameter / <math>\mu\text{m}</math></b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>spread of diameters / <math>\mu\text{m}</math></b> |                                                                            |                                                       |                   |          |       |                   |          |       |          |
| <b>young mice</b> | 35 at 30                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 16–44                                                 |                                                                            |                                                       |                   |          |       |                   |          |       |          |
| <b>adult mice</b> | 16 at 50                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 20–80                                                 |                                                                            |                                                       |                   |          |       |                   |          |       |          |

| Question                            | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Marks |        |                               |     |                                     |          |                                 |     |                               |          |   |
|-------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|--------|-------------------------------|-----|-------------------------------------|----------|---------------------------------|-----|-------------------------------|----------|---|
| 8(a)                                | <table><tr><td></td><td>letter</td></tr><tr><td>high concentration of protons</td><td>M ;</td></tr><tr><td>location of photosynthetic pigments</td><td>L or N ;</td></tr><tr><td>site of light-independent stage</td><td>K ;</td></tr><tr><td>site of light-dependent stage</td><td>L or N ;</td></tr></table> <p><i>ignore <b>M</b> in the last row</i></p>                                                                                                    |       | letter | high concentration of protons | M ; | location of photosynthetic pigments | L or N ; | site of light-independent stage | K ; | site of light-dependent stage | L or N ; | 4 |
|                                     | letter                                                                                                                                                                                                                                                                                                                                                                                                                                                          |       |        |                               |     |                                     |          |                                 |     |                               |          |   |
| high concentration of protons       | M ;                                                                                                                                                                                                                                                                                                                                                                                                                                                             |       |        |                               |     |                                     |          |                                 |     |                               |          |   |
| location of photosynthetic pigments | L or N ;                                                                                                                                                                                                                                                                                                                                                                                                                                                        |       |        |                               |     |                                     |          |                                 |     |                               |          |   |
| site of light-independent stage     | K ;                                                                                                                                                                                                                                                                                                                                                                                                                                                             |       |        |                               |     |                                     |          |                                 |     |                               |          |   |
| site of light-dependent stage       | L or N ;                                                                                                                                                                                                                                                                                                                                                                                                                                                        |       |        |                               |     |                                     |          |                                 |     |                               |          |   |
| 8(b)                                | <p><i>any <b>four</b> from:</i></p> <p>1    any one named ; e.g. chlorophyll b / carotene / xanthophyll / carotenoids ;</p> <p>2    act as accessory pigments / part of antenna complex / part of light harvesting system ;</p> <p>3    absorb, light / photons ;</p> <p>4    pass <u>energy</u> on to, chlorophyll a / primary pigment / reaction centre ;</p> <p>5    absorb different wavelengths of light / wavelengths not absorbed by chlorophyll a ;</p> | 4     |        |                               |     |                                     |          |                                 |     |                               |          |   |

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| Question        | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Marks           |                          |  |       |         |     |     |     |     |     |     |     |     |     |     |     |      |     |     |      |     |     |      |     |     |      |     |     |     |     |      |     |     |      |     |     |     |     |          |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|--------------------------|--|-------|---------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|-----|-----|------|-----|-----|------|-----|-----|------|-----|-----|-----|-----|------|-----|-----|------|-----|-----|-----|-----|----------|
| 8(c)            | <p>1 absorption higher for (whole) chloroplasts (throughout) ;</p> <p>2 comparative data quote <b>or</b> greatest difference at 525 / 530 nm ;</p> <table border="1"> <thead> <tr> <th rowspan="2">wavelength / nm</th><th colspan="2">absorbance / au<br/>±0.05</th></tr> <tr> <th>whole</th><th>pigment</th></tr> </thead> <tbody> <tr><td>500</td><td>9.2</td><td>6.4</td></tr> <tr><td>510</td><td>8.4</td><td>3.8</td></tr> <tr><td>520</td><td>7.4</td><td>2.3</td></tr> <tr><td>525</td><td>7.0</td><td>1.95</td></tr> <tr><td>530</td><td>6.6</td><td>1.85</td></tr> <tr><td>540</td><td>6.2</td><td>2.05</td></tr> <tr><td>550</td><td>5.8</td><td>2.35</td></tr> <tr><td>560</td><td>5.8</td><td>2.7</td></tr> <tr><td>600</td><td>6.65</td><td>4.7</td></tr> <tr><td>650</td><td>8.85</td><td>8.1</td></tr> <tr><td>670</td><td>9.6</td><td>9.2</td></tr> </tbody> </table> <p>3 (because) pigments arranged for better absorption in chloroplasts / thylakoid membranes are stacked / AW ;</p> <p>4 (because) chloroplasts contain more pigments ;</p> | wavelength / nm | absorbance / au<br>±0.05 |  | whole | pigment | 500 | 9.2 | 6.4 | 510 | 8.4 | 3.8 | 520 | 7.4 | 2.3 | 525 | 7.0 | 1.95 | 530 | 6.6 | 1.85 | 540 | 6.2 | 2.05 | 550 | 5.8 | 2.35 | 560 | 5.8 | 2.7 | 600 | 6.65 | 4.7 | 650 | 8.85 | 8.1 | 670 | 9.6 | 9.2 | <b>4</b> |
| wavelength / nm | absorbance / au<br>±0.05                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                 |                          |  |       |         |     |     |     |     |     |     |     |     |     |     |     |      |     |     |      |     |     |      |     |     |      |     |     |     |     |      |     |     |      |     |     |     |     |          |
|                 | whole                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | pigment         |                          |  |       |         |     |     |     |     |     |     |     |     |     |     |     |      |     |     |      |     |     |      |     |     |      |     |     |     |     |      |     |     |      |     |     |     |     |          |
| 500             | 9.2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 6.4             |                          |  |       |         |     |     |     |     |     |     |     |     |     |     |     |      |     |     |      |     |     |      |     |     |      |     |     |     |     |      |     |     |      |     |     |     |     |          |
| 510             | 8.4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 3.8             |                          |  |       |         |     |     |     |     |     |     |     |     |     |     |     |      |     |     |      |     |     |      |     |     |      |     |     |     |     |      |     |     |      |     |     |     |     |          |
| 520             | 7.4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 2.3             |                          |  |       |         |     |     |     |     |     |     |     |     |     |     |     |      |     |     |      |     |     |      |     |     |      |     |     |     |     |      |     |     |      |     |     |     |     |          |
| 525             | 7.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 1.95            |                          |  |       |         |     |     |     |     |     |     |     |     |     |     |     |      |     |     |      |     |     |      |     |     |      |     |     |     |     |      |     |     |      |     |     |     |     |          |
| 530             | 6.6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 1.85            |                          |  |       |         |     |     |     |     |     |     |     |     |     |     |     |      |     |     |      |     |     |      |     |     |      |     |     |     |     |      |     |     |      |     |     |     |     |          |
| 540             | 6.2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 2.05            |                          |  |       |         |     |     |     |     |     |     |     |     |     |     |     |      |     |     |      |     |     |      |     |     |      |     |     |     |     |      |     |     |      |     |     |     |     |          |
| 550             | 5.8                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 2.35            |                          |  |       |         |     |     |     |     |     |     |     |     |     |     |     |      |     |     |      |     |     |      |     |     |      |     |     |     |     |      |     |     |      |     |     |     |     |          |
| 560             | 5.8                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 2.7             |                          |  |       |         |     |     |     |     |     |     |     |     |     |     |     |      |     |     |      |     |     |      |     |     |      |     |     |     |     |      |     |     |      |     |     |     |     |          |
| 600             | 6.65                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 4.7             |                          |  |       |         |     |     |     |     |     |     |     |     |     |     |     |      |     |     |      |     |     |      |     |     |      |     |     |     |     |      |     |     |      |     |     |     |     |          |
| 650             | 8.85                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 8.1             |                          |  |       |         |     |     |     |     |     |     |     |     |     |     |     |      |     |     |      |     |     |      |     |     |      |     |     |     |     |      |     |     |      |     |     |     |     |          |
| 670             | 9.6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 9.2             |                          |  |       |         |     |     |     |     |     |     |     |     |     |     |     |      |     |     |      |     |     |      |     |     |      |     |     |     |     |      |     |     |      |     |     |     |     |          |

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| Question | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Marks    |
|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| 9(a)(i)  | <p><i>any <b>four</b> from:</i></p> <ol style="list-style-type: none"> <li>1 (dopamine) diffuses across synaptic cleft ;</li> <li>2 binds to receptors ;</li> <li>3 on postsynaptic <u>membrane</u> ;</li> <li>4 Na<sup>+</sup> channels open <b>R</b> voltage gated channels<br/><b>or</b><br/>influx of Na<sup>+</sup> into post synaptic neurone ;</li> <li>5 depolarisation of postsynaptic <u>membrane</u> ;</li> <li>6 <i>ref.</i> threshold ;</li> </ol> | <b>4</b> |
| 9(a)(ii) | dopaquinone ; <b>A</b> melanin                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>1</b> |
| 9(b)     | <p><i>any <b>three</b> from:</i></p> <ol style="list-style-type: none"> <li>1 Cl<sup>-</sup> influx makes (inside of postsynaptic neurone) more negative / stays negative ;</li> <li>2 hyperpolarisation / remains polarised ;</li> <li>3 (not enough Na<sup>+</sup> enter so) less likely to reach threshold ;</li> <li>4 no depolarisation of (postsynaptic) membrane ;</li> <li>5 (so) no action potential ;</li> </ol>                                      | <b>3</b> |

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| Question | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Marks |                                    |   |                |  |   |               |     |            |   |   |                                |     |                            |   |   |             |     |                            |   |   |          |     |        |   |   |                |     |                   |   |   |                          |     |                                    |   |   |                                  |     |                              |   |   |
|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------------------------------------|---|----------------|--|---|---------------|-----|------------|---|---|--------------------------------|-----|----------------------------|---|---|-------------|-----|----------------------------|---|---|----------|-----|--------|---|---|----------------|-----|-------------------|---|---|--------------------------|-----|------------------------------------|---|---|----------------------------------|-----|------------------------------|---|---|
| 10(a)    | <p>any <b>four</b> from:</p> <table><tr><td></td><td><b>Animalia</b></td><td></td><td><b>Plantae</b></td><td></td></tr><tr><td>1</td><td>no cell walls</td><td>and</td><td>cell walls</td><td>;</td></tr><tr><td>2</td><td>no, chlorophyll / chloroplasts</td><td>and</td><td>chlorophyll / chloroplasts</td><td>;</td></tr><tr><td>3</td><td>heterotroph</td><td>and</td><td>autotroph / photosynthesis</td><td>;</td></tr><tr><td>4</td><td>glycogen</td><td>and</td><td>starch</td><td>;</td></tr><tr><td>5</td><td>nervous system</td><td>and</td><td>no nervous system</td><td>;</td></tr><tr><td>6</td><td>move from place to place</td><td>and</td><td>unable to move from place to place</td><td>;</td></tr><tr><td>7</td><td>no, permanent / central, vacuole</td><td>and</td><td>permanent / central, vacuole</td><td>;</td></tr></table> |       | <b>Animalia</b>                    |   | <b>Plantae</b> |  | 1 | no cell walls | and | cell walls | ; | 2 | no, chlorophyll / chloroplasts | and | chlorophyll / chloroplasts | ; | 3 | heterotroph | and | autotroph / photosynthesis | ; | 4 | glycogen | and | starch | ; | 5 | nervous system | and | no nervous system | ; | 6 | move from place to place | and | unable to move from place to place | ; | 7 | no, permanent / central, vacuole | and | permanent / central, vacuole | ; | 4 |
|          | <b>Animalia</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |       | <b>Plantae</b>                     |   |                |  |   |               |     |            |   |   |                                |     |                            |   |   |             |     |                            |   |   |          |     |        |   |   |                |     |                   |   |   |                          |     |                                    |   |   |                                  |     |                              |   |   |
| 1        | no cell walls                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | and   | cell walls                         | ; |                |  |   |               |     |            |   |   |                                |     |                            |   |   |             |     |                            |   |   |          |     |        |   |   |                |     |                   |   |   |                          |     |                                    |   |   |                                  |     |                              |   |   |
| 2        | no, chlorophyll / chloroplasts                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | and   | chlorophyll / chloroplasts         | ; |                |  |   |               |     |            |   |   |                                |     |                            |   |   |             |     |                            |   |   |          |     |        |   |   |                |     |                   |   |   |                          |     |                                    |   |   |                                  |     |                              |   |   |
| 3        | heterotroph                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | and   | autotroph / photosynthesis         | ; |                |  |   |               |     |            |   |   |                                |     |                            |   |   |             |     |                            |   |   |          |     |        |   |   |                |     |                   |   |   |                          |     |                                    |   |   |                                  |     |                              |   |   |
| 4        | glycogen                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | and   | starch                             | ; |                |  |   |               |     |            |   |   |                                |     |                            |   |   |             |     |                            |   |   |          |     |        |   |   |                |     |                   |   |   |                          |     |                                    |   |   |                                  |     |                              |   |   |
| 5        | nervous system                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | and   | no nervous system                  | ; |                |  |   |               |     |            |   |   |                                |     |                            |   |   |             |     |                            |   |   |          |     |        |   |   |                |     |                   |   |   |                          |     |                                    |   |   |                                  |     |                              |   |   |
| 6        | move from place to place                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | and   | unable to move from place to place | ; |                |  |   |               |     |            |   |   |                                |     |                            |   |   |             |     |                            |   |   |          |     |        |   |   |                |     |                   |   |   |                          |     |                                    |   |   |                                  |     |                              |   |   |
| 7        | no, permanent / central, vacuole                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | and   | permanent / central, vacuole       | ; |                |  |   |               |     |            |   |   |                                |     |                            |   |   |             |     |                            |   |   |          |     |        |   |   |                |     |                   |   |   |                          |     |                                    |   |   |                                  |     |                              |   |   |
| 10(b)(i) | <p><math>\frac{0.86 - 0.28}{4}</math> <b>or</b> <math>\frac{0.58}{4}</math> ;</p> <p>0.15 ;</p> <p><b>or</b></p> <p><math>\frac{0.85 - 0.28}{4}</math> <b>or</b> <math>\frac{0.57}{4}</math> ;</p> <p>0.14 ;</p> <p><i>Allow ecf if divided by 5 and equals 0.12</i></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 2     |                                    |   |                |  |   |               |     |            |   |   |                                |     |                            |   |   |             |     |                            |   |   |          |     |        |   |   |                |     |                   |   |   |                          |     |                                    |   |   |                                  |     |                              |   |   |

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| Question  | Answer                                                                                                                                                                                                                                                                                                                                                   | Marks    |
|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| 10(b)(ii) | <p><i>any <b>three</b> from:</i></p> <ol style="list-style-type: none"> <li>1 climate change / described ;</li> <li>2 less food / less watermilfoil ;</li> <li>3 less, snow / cover, so more predation ;</li> <li>4 more hunting ;</li> <li>5 increased competition ;</li> <li>6 loss of habitat / deforestation ;</li> <li>7 (new) disease ;</li> </ol> | <b>3</b> |